

ScanEx IMAGE Processor version 1.0

TERRAIN Module

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The **TERRAIN** Module is a powerful tool providing for the 3D terrain modeling and display. An **Elevation map** and the **RGB texture** are the main elements of the 3D terrain model.

Raster digital elevation models (**DEM**) and digital elevation models in the **GRID** format are used as the **Elevation maps**. The elevation values can be stored in the both integer and real format. This application is intended for the following types of digital elevation models:

- Digital elevation models in the **SURFER GRID** format.
- Digital elevation models in the **ArcInfo ASCII GRID** format.
- Digital elevation models in the **ArcInfo Binary GRID** format.
- Digital elevation models in the **USGS DEM** format.
- Digital model **SRTM** (Shuttle Radar Topography Mission).
- Digital model **GTOPO30**.
- Digital elevation models in the supported raster formats (**GeoTIFF**, **ESRI BILABSQ**, **ERDAS Imagine IMG**, etc.) for which elevations are defined as brightness values.

Digital elevation models can be presented in any of the supported coordinate systems.

For the **RGB textures** space and aerial images are used. There is a possibility to create 3D terrain models based on images of various types and resolution without their reduction to the single spatial resolution.

In order to make 3D Terrain more realistic you may place 3D objects (buildings, trees, vehicles, etc.) on it. The 3D models can be imported to the application in the exchange format of the **3D Studio MAX (*.3ds)** package.

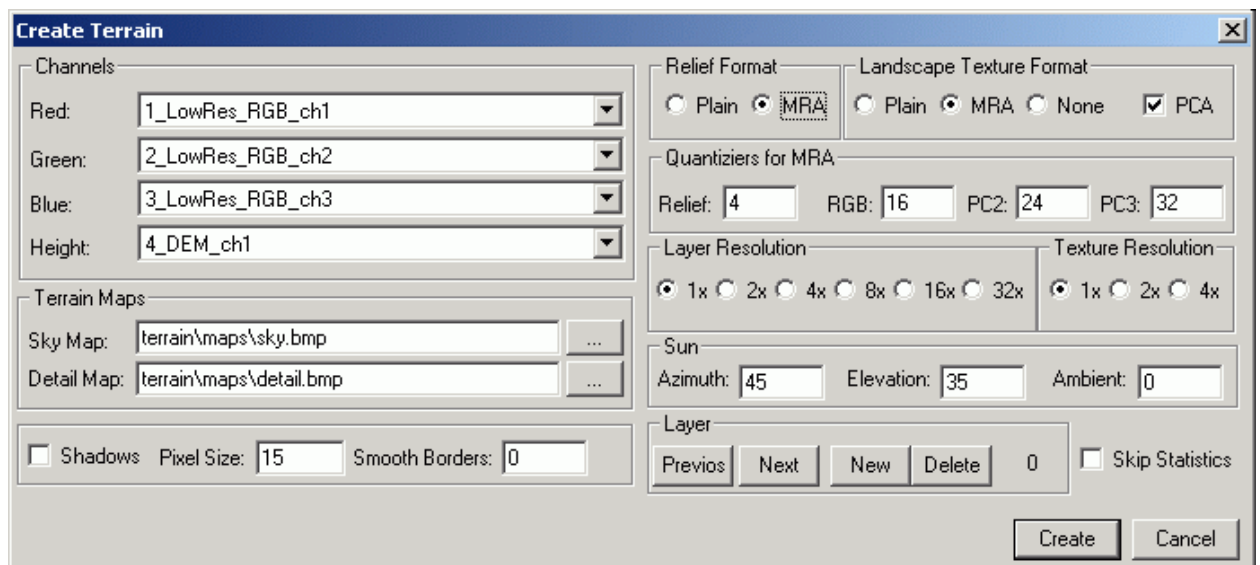
In addition the embedded algorithms allow to interactively create certain 3D objects like trees, clouds or smoke. The 2D textures of both the vertical (**sprite**) and horizontal (**sticker**) arrangement may be also used.

There is also a possibility of displaying thematic maps (e.g. vegetation maps, thermal maps, etc.). Thematic maps may be represented as the vector layers in the **Mapinfo MIF** and **ESRI SHP** formats as well as the binary raster masks.

3D Terrain Creation

A procedure of creating a 3D Terrain is as follows:

1. Create a *Working project* and load data (a digital elevation model and an image to be used as the RGB texture).
2. Fulfill an image geometrical correction if it has not been done yet.
3. Set a color palette for the RGB texture.
4. Set the *working area* (**Extent**).
5. Use command **Terrain**→**Create Terrain** of the *Main menu*. The **Create Terrain dialog** appears.



Group Channels defines the RGB texture and the elevation map:

- List Red* : defines the RGB texture's red channel.
- List Green* : defines the RGB texture's green channel.
- List Blue* : defines the RGB texture's blue channel.
- List Height* : defines the elevation map.

Group Terrain Maps defines the sky's texture and the texture to be used for the sharpness increase while zooming:

- List Sky Map* : defines the sky texture file. Sky textures can be in the **BMP**, **JPG**, **GIF** and **TGA** formats and the picture size is a degree of 2.
- List Detail Map* : specifies a file with the highly detailed texture. These files can be in the **BMP**, **JPG**, **GIF** and **TGA** formats and the picture size is a degree of 2.

In this application the Wavelet transform is used to compress elevation maps and RGB textures. Due to compression the 3D terrain volume decreases up to 30 times almost without losses in the image quality.

Group Relief Format defines the compression type for the elevation map:

Switch Plain switches off the compression mode and the elevation map is loaded in the **float32** format. We do not recommend this option for large terrain creation.

Switch MRA switches on the Wavelet transform compression mode.

Group Landscape Texture Format defines the compression type for the RGB texture.

Switch Plain switches off the compression mode. In this case 4 bytes of the video buffer are allocated for 1 pixel of the RGB texture. We do not recommend this option for large terrain creation.

Switch MRA switches on the Wavelet transform compression mode.

Switch None switches off the RGB texture usage.

Flag PCA enables a mode of the RGB texture principal component analysis and subsequent compression based on each component Wavelet transform. This option reduces the 3D terrain volume due to the various ratio compression of the extracted principal components with. As the second and third principal components (**PC2** and **PC3**) are less informative than the first one (**PC1**), it is possible to increase the compression ratio for the second and third components almost without losses in the image quality as a whole.

Group Quantizers for MRA defines parameters for the Wavelet compression of elevation maps and RGB textures.

Field Relief : defines a compression ratio for the elevation map. Small values reduce the compression ratio and the high ones - increase.

Field RGB : defines a compression ratio for the RGB texture; in case of enabling principal components analysis - the compression ratio for the 1st principal component (**PC1**).

Field PC2 : defines a compression ratio for the 2nd principal component (**PC2**).

Field PC3 : defines a compression ratio for the 3rd principal component (**PC3**).

Groups Layer Resolution and **Texture Resolution** are used for creating 3D terrains with various RGB textures' resolution and the elevation maps' grid step. This option provides for a possibility of creating a 3D scene with many levels of detail, i.e. a «**basic layer**» (an RGB texture and an elevation map) with one spatial resolution and the layers with better spatial resolution («**detail layers**») are created. For example, when creating a 3D scene for a certain administrative district the RGB texture with a resolution of 30 m/pixel and a detailed insert for a large city with a resolution of 1 m/pixel are used.

Group Layer Resolution defines spatial resolution of a «**detail layer**» relative to the «**basic layer**». The value **1x** means that there is no zoom, the value **32x** corresponds to the 32-fold zoom relative to the «**basic layer**».

Group Texture Resolution defines spatial resolution of the RGB texture relative to the zoom factor of the «**detail layer**». This option provides for unloading both the Central processor (CPU) and the Graphical processor (GPU) when displaying a 3D scene due to reducing level of detail during this elevation map unpacking and visualization. E.g. a 3D scene is to be compiled from a «**basic layer**» with a resolution of 30 m/pixel and a «**detail layer**» with a 4 m/pixel resolution. There are two ways of solving this task. The first one is to define **Layer Resolution** as **8x** for the «**detail layer**». Thus, the whole «**detail layer**» including the RGB texture and the elevation map will have eight times more details compared to the «**basic layer**» ($30 / 8 = 3.75$ m/pixel). The second way is to set the **Layer Resolution** equal to **4x** and the **Texture Resolution** - to **2x**. In this case the elevation map will have twice more details ($30 / 4 = 7.5$ m/pixel) and the RGB texture will have eight times more details compared to the «**basic layer**» ($(30 / (2 \cdot 4)) = 3.75$ m/pixel).

Group **Sun** defines the Sun position for the shadow calculation.

Field **Azimuth** : defines the Sun azimuth in degrees.

Field **Elevation** : defines the Sun elevation in degrees.

Field **Ambient** : defines the background illumination.

Group **Layer** defines navigation around the layers.

Button **Previous** : press the button to move to the previous layer.

Button **Next** : press the button to move to the next layer.

Button **New** : press the button to create a new layer.

Button **Delete** : press the button to delete the current layer.

A figure right to the **Delete** *button* indicates the current layer's number. The value "0" corresponds to the «**basic layer**».

Flag **Skip Statistics** switches off / on statistics during the 3D terrain creation. This provides for reducing calculations and consequently the frame creation time. It is possible to calculate statistics after the 3D terrain creation.

Flag **Shadows** switches on / off shadow calculation.

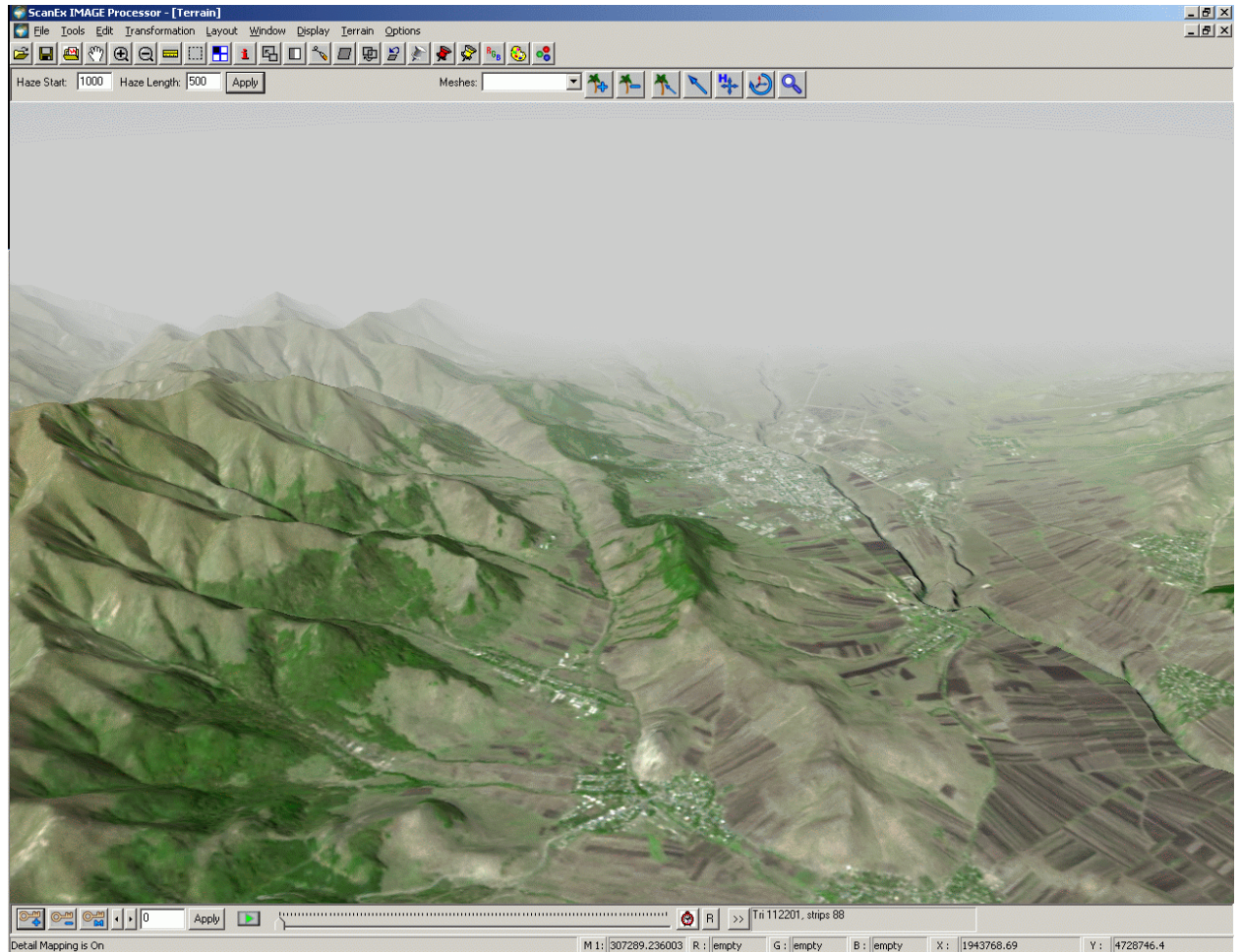
Field **Pixel Size** : defines a pixel size for the «**basic layer**».

Field **Smooth Borders** defines the number of iterations for the smoothing filter on the «**detail layer**» / «**basic layer**» boundary. The filtering window is 3 x 3 pixels and the number of the pixels from the boundary to be smoothed is set.

On completing the calculation procedure the software automatically changes for the 3D terrain viewing mode.

3D Terrain Viewing Mode

The **Terrain** mode is used to display 3D terrains. In order to enter the **Terrain** mode load the created 3D scene using the command **Terrain→Load Terrain** of the *Main menu*. After the 3D terrain calculation the program automatically transfers to the **Terrain** mode.



Terrain Mode Toolbar

The *Toolbar* is located in the upper part of the *display window*.



The left control group provides for controlling the haze display parameters.

Field Haze Start : defines the lowest edge of the haze (in meters). A haze makes a 3D scene more realistic as well as reduces the load onto the Central (CPU) and Graphical (GPU) processors.

Field Haze Length : defines the «transparency depth» of the haze (in meters).

Button Apply : press the button to apply the haze display parameters set.


Flag Land inhibits changing the camera's altitude; this option is used to animate objects and models.


The right control group is used to control 3D objects.

List Meshes : press the button to open a list of the 3D objects added to the scene.

A Flag (to the right from the **list Meshes**) switches on / off displaying all the copies for the 3D object type selected in the **list Meshes**.



Button Add Mesh  adds the 3D model.




Button Remove Mesh  removes either a 3D model or an object.


Button Add Instance  adds a copy of a 3D model or an object from the **list Meshes**.


Button Select Instance  selects a 3D model or a 3D object.


Button Move Instance moves the selected 3D model or object. The 3D models can be moved in the both vertical and horizontal planes. When moving an object in the horizontal plane the **Move**

Instance *button* looks as ; when moving in the vertical plane - like . Press button repeatedly to toggle modes.

Button Rotate Instance rotates the selected 3D models and objects in three planes. For rotation in the horizontal plane this *button* looks like ; for rotation in the vertical plane it is as follows ; and for changing the roll it is as . Press button repeatedly to toggle modes.

Button Scale Instance  interactively changes the size of the selected 3D models and objects.

Button Attach Instance  provides for attaching the camera to the selected 3D object; this option is used to animate the 3D objects and models.

Button Detach Instance  detaches the camera from the 3D object; this option is used to animate the 3D objects and models.

The Terrain Module Main Menu

In this section the description of menu items and subitems is given.

Terrain→Create Terrain - the **Create Terrain dialog** appears allowing to create the new 3D terrain.

Terrain→Load Terrain - a file with the saved 3D terrain is loaded.

Terrain→Save Terrain - the active 3D terrain is saved into a file.

Terrain→Batch Creation – a new 3D terrain is saved in a batch mode.

Terrain→Load State – a flyby trajectory is loaded from a file.

Terrain→Save State – a flyby trajectory is saved into a file.

Terrain→Load Sky - a sky texture is loaded.

Terrain→Load Detail Texture - a detail texture is loaded.

Terrain→Load Skin - a stylized instance (a control panel, etc.) is loaded.

Terrain→Objects – a 3D object creation and change.

Terrain→Objects→Create Clouds - the **Create Clouds / Volumetric Fog dialog** appears providing for the cloud and fog creation.

Terrain→Objects→Create Smoke - the **New Smoke dialog** appears providing for smoke creation.

Terrain→Objects→Create Sprite - the **New Sprite dialog** appears providing for the creation of 2D textures with the vertical disposition.

Terrain→Objects→Create Sticker - the **New Sticker dialog** appears providing for the creation of 2D textures with the horizontal disposition.

Terrain→Objects→Create Tree - the **New Procedure Tree dialog** appears providing for the creation of trees.

Terrain→Objects→Add Vector Layer - the **Add Vector Object dialog** appears providing for the vector layer loading.

Terrain→Objects→Properties - a *dialog* appears where the 3D objects' properties are set.

Terrain→Instances – control of the 3D models and objects added to the 3D terrain.

Terrain→Instances→Select All - selecting all the 3D models and objects added to the 3D terrain.

Terrain→Instances→Select Mesh - selecting all the copies of the 3D objects chosen in the *Meshes list*.

Terrain→Instances→Delete - removal of all the selected models and objects.

Terrain→Instances→Land - leveling the 3D models and objects relative to the ground surface.

Terrain→Instances→Freeze - disabling selection, move and zoom of the 3D models and objects placed.

Terrain→Instances→Unfreeze - enabling selection, move and zoom of the 3D models and objects.

Terrain→Instances→Animate - initializes animation of the 3D models and objects.

Terrain→Generate Instances - the **Generate Instances dialog** appears providing for automated adding copies of the 3D objects and models to the 3D landscape.

Terrain→Layers - adding raster thematic layers to a 3D scene.

Terrain→Layers→Add Thematic Layer - the **Add Thematic Layers dialog** appears, where new raster thematic layer can be added.

Terrain→Layers→Delete Last Thematic Layer - deletes the last-loaded raster thematic layer.

Terrain→Layers→Tune Water - the **Water Properties dialog** appears where the properties of the “water” thematic layer can be set.

Terrain→Options - control of the 3D terrain display parameters.

Terrain→Options→Wire Landscape - switching on/off the coordinate grid when displaying the 3D terrain.

Terrain→Options→Wire Meshes - switching on/off the coordinate grid when displaying 3D models.

Terrain→Options→Motion Blur - enables / disables **motion blur** mode.

Terrain→Options→Sky Sphere - enables / disables the sky display mode.

Terrain→Options→Detail Mapping - enables / disables the detail texture display mode.

Terrain→Options→Thematic Mapping - enables / disables the raster thematic layer display mode.

Terrain→Options→Meshes - enables / disables the display mode for all the 3D objects and models added.

Terrain→Options→Haze - enables / disables the haze display mode.

Terrain→Options→Navigator - enables / disables the navigation mode.

Terrain→Options→Transparent Sprites - enables / disables the mode of transparency for the 2D textures of vertical disposition.

Terrain→Options→Switch Layers - enables / disables the mode of displaying the «**basic layer**» and the «**detail layer**» for the 3D landscapes.

Terrain→Freeze Scene - enables / disables the rendering inhibit outside the visible region.

Terrain→Reload Textures - display window repainting.

Terrain→Recalculate Statistics – a new calculation of the 3D terrain statistics.

Terrain→Delete All Keys - deleting all the key frames from the flyby trajectory.

Terrain→Capture Video - the **Video Capture dialog** appears, where the flyby trajectory can be saved in a video clip.

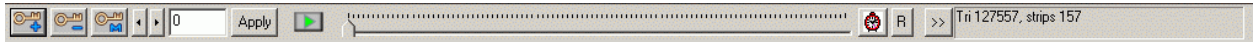
Terrain→LOD Control - the **Level of Detail Control dialog** appears providing for controlling the 3D terrain display level of detail.

Terrain→Preferences - the **Preferences dialog** appears, where rendering parameters are set.

Terrain→Information outputs information on the current 3D terrain.


Status bar




The *Status bar* is located in the lower part of the *display window* and has the following control tools.




Button Add Key  adds a new key frame to the flyby trajectory.

Button Delete Key  deletes the current key frame from the flyby trajectory.


Button Modify Key  opens the **Modify Key** dialog where the parameters of the current key frame can be changed.


Buttons and field    provide for navigation around the key frames.

Button Apply provides for a transfer to the fixed key frame.

Button Play/Stop  - start / stop of automated flyby along the saved trajectory.


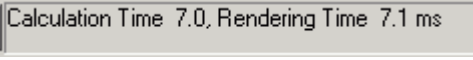
Slider  provides for navigation around the key frames.

Button Time Configuration  opens the **Time Configuration** dialog where the flyby trajectory parameters are set.

Button Record  starts the flyby trajectory creation.

An information panel with the statistics for the current key frame is located in the right part of the Status bar. In order to look through the below given properties press the *button* >>.



The mode   shows the number of multi triangles (**multi triangles**) and strips of the multi triangles (**Strips**) for the current frame.

The mode   shows the CPU time for the current frame calculation (**Calculation Time**, in ms) and the GPU time for this frame rendering (**Rendering Time**, in ms).

The mode   shows the current frame display frequency (**Frame per second**).

The mode   shows the current speed of the camera motion (**Speed** : in km/h, in brackets there given the percentage of the utmost possible speed).

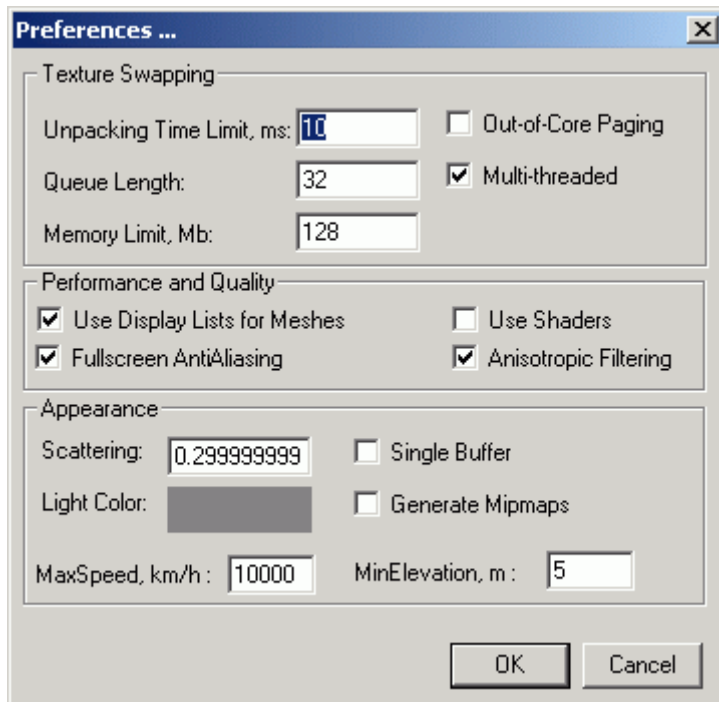
The mode   shows the current height of the camera in meters (**Camera Height**).

The mode   shows camera's current position (**Camera Position**) in decimal degrees.

The Module's Preferences

Setting the rendering parameters

The rendering parameters are set in the **Preferences dialog** opened by the **Terrain→Preferences** command.



Group Texture Swapping defines the RGB texture unpacking speed.

Field Unpacking Time Limit, ms : defines the maximal time allocated for one texture unpacking (in milliseconds). This parameter increase provides for displaying a larger number of textures but reduces the operation efficiency. The value decrease improves the performance, but causes the risk of the quality worsening since texture unpacking time will be too short to complete the procedure.

Field Queue Length : defines the maximal number of textures to be unpacked in a single frame. The greater the parameter, the less the operation efficiency and the better the quality. The smaller the parameter, the higher operation efficiency and the less the quality due to a small number of textures.

Field Memory Limit, Mb : defines the limit for the video memory usage (in Mb).

Flag Out-Of-Core-Paging enables / disables a mode making it possible not to load the 3D terrain into the RAM. This option reduces the rendering speed but allows large 3D frame displaying. In addition this option is recommended if a computer has a small RAM. After changing the mode it is necessary to restart the module (reload the 3D frame).

Flag Multi-threaded enables / disables a mode allowing the second CPU operation. This option can be activated either for the dual-processor configuration or a computer with the **Intel Pentium IV** processor and the **Hyper-Threading** technology. On this option enabling the first processor manages the texture swapping and the second processor provides for texture unpacking thus giving a gain in efficiency.

Group Performance and Quality defines parameters of the 3D frame display quality.

*Flag **Fullscreen AntiAliasing*** enables / disables a fullscreen antialiasing. Fullscreen antialiasing improves the visualization quality but reduces operation efficiency.

*Flag **Use Display Lists for Meshes*** enables / disables the commands from the **Display Lists** of the **OpenGL** library. This option makes it possible to increase the operation efficiency for the 3D models rendering.

*Flag **Use Shaders*** enables / disables the mode of using pixel and vertex shaders.

*Flag **Anisotropic Filtering*** enables / disables the mode of anisotropic filtering providing for the image quality improvement in the **MipMapping** mode.

*Group **Appearance*** defines the 3D terrain display parameters.

*Field **Scattering*** : defines the haze height above the horizon.

*Field **Light Color*** : selects the color for the 3D model illumination.

*Field **Maximal Speed, km/h*** : defines the maximal speed of the camera motion over the 3D terrain (in km/h).

*Flag **Single Buffer*** enables/disables usage of one (on-screen) video buffer instead of two (on-screen and off-screen) buffers. When the flag is on, the data is directly output to the on-screen buffer and when it is off the data is loaded to the off-screen buffer and then copied to the on-screen buffer. This mode is recommended when the **Motion Blur** mode is activated for the video adapter of the **ATI RADEON** family. It is necessary to reload the 3D terrain after this mode changing.

*Flag **Generate Mipmaps*** enables / disables usage of the **MipMapping** hardware mode (implemented in the video adapter). **MipMapping** is the technique to improve the images' texture quality using different resolution textures for different objects of the same frame. An alternative **MipMapping** version implemented in the program is enabled if the flag is off.

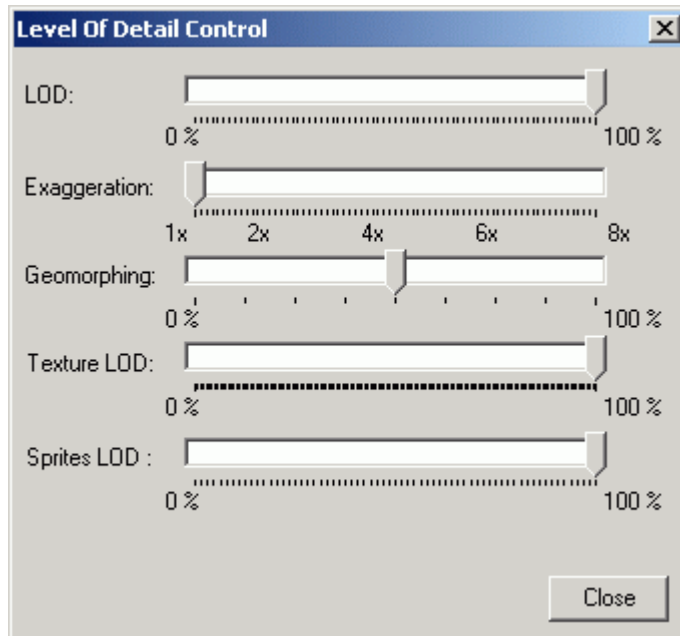
*Field **MinElevation, m*** : defines the minimal flight height. The value is set relative to the height in the current point in meters.

*Button **OK*** closes the dialog; all the changes are accepted.

*Button **Cancel*** closes the dialog; all the changes are rejected.

Level of Detail Control for the 3D Terrain Display

The **Level of Detail Control** *dialog* provides for controlling the 3D terrain display quality. In order to open the dialog select the *command* **Terrain→LOD Control** (CTRL+ALT+C) in the *Main menu*.



Slider **LOD** : controls the level of detail for the elevation map. The less the level of detail, the higher the operation efficiency and the worse the display quality (due to artifacts like abnormal appearance or disappearance of the vertices).

Slider **Exaggeration** : controls the elevation map vertical scale.

Slider **Geomorphing** : controls compensation for the artifacts appearing in the LOD mode. **Geomorphing** is a smooth rising or lowering of the vertex height. For the low **LOD** value it is recommended to set the maximal **Geomorphing** value.

Slider **Texture LOD** : controls the level of detail for the RGB texture. This option makes it possible to increase operating efficiency at the expense of the image quality decrease.

Slider **Sprites LOD** : controls the level of detail for displaying 2D textures of vertical disposition.

Button **Close** : press the button to close the *dialog*.

Camera Motion Control

The camera motion is controlled using a keyboard, a mouse and a joystick.

Keyboard control

Start engine	= Q
Increase speed	= A
Decrease speed	= D
Level	= S
Motion forwards (the engine is switched off)	= ↑
Motion backwards (the engine is switched off)	= ↓
Turn left	= ←
Turn right	= →
Vertical up	= Page Up
Vertical down	= Page Down

Mouse control

Turn left – move the mouse keeping the left button depressed.

Turn right – move the mouse to the right keeping the left button depressed.

Upwards – move the mouse forward keeping the left button depressed.

Downwards – move the mouse backward keeping the left button depressed.

Level – press the right button.

Joystick control

Motion downwards – push the handle away from you.

Motion upwards – pull the handle toward you.

Roll left – move the handle left.

Roll right – move the handle right.

Turn left – press the joystick's button 2.

Turn right – press the joystick's button 3.


Level – press the joystick's button 4.

Speed increase / decrease – the joystick's third axis.

You may change the control button destination in the file **flcontrol.ini**, in the root directory.




Flyby Trajectory Creation

A flyby trajectory is used to both animate the 3D models and record video clips.


Press the **Record**  button in the *Task bar* in order to define the flyby trajectory and fly along the specified path. On completion press the *button* **Record** again. If you need to move over the landscape surface (e.g. car motion simulation) check the *flag* **Land** in the *Toolbar* beforehand. This disables camera raise above the minimal height relative to the surface level.

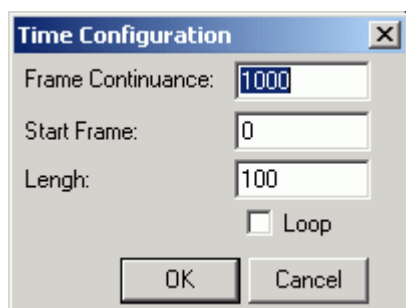
To save the created trajectory into a file select the *command* **Terrain→Save State** in the *Main menu*. In order to load the saved trajectory select the *command* **Terrain→Load State** in the *Main menu*.

Flyby Along the Created Trajectory

To flyby along the created trajectory, set the number of the key frame to start playback with in the *field*  and press the *button* **Play \ Stop** . To stop the process, press the **Play \ Stop**  button again.

Editing the Flyby Trajectory Properties

In order to edit the trajectory's properties press the *button*  located in the *Task bar*. The **Time Configuration** *dialog* appears.



Field **Frame Continuance** : defines the key frame duration in milliseconds.

Field **Start Frame** : defines the number of the first frame.

Field **Length** : defines the number of a frames for replay.



Flag **Loop** enables / disables continuous replay.

Button **Ok** : press the button to initialize the process.



Button **Cancel** : press the button to close the *dialog*.

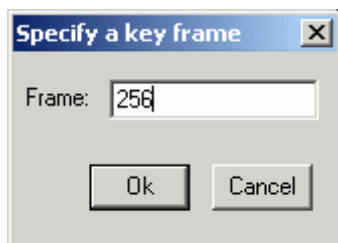
Properties of the Flyby Trajectory's Key Frames

Key frame removal

In order to delete the required key frame, select the relevant number in the *field*  and press the *button*  in the *Task bar*. A request to confirm the operation appears and after approval the chosen key frame is deleted.

New key frame addition

In order to add a new key frame set the number indicating the place where the key frame should be added in the *field*  and press the *button*  in the *Task bar*. The *dialog Specify a key frame* appears.





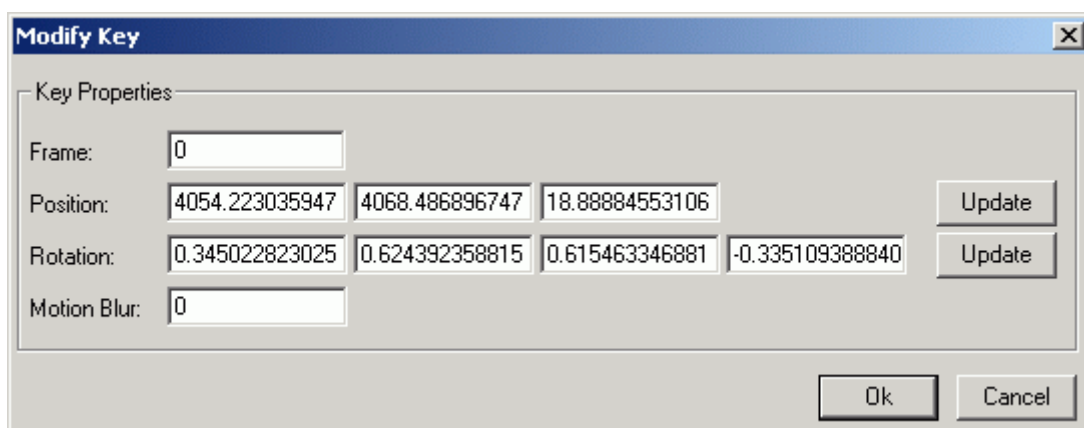
Field Frame : defines the number of the new key frame.

Button Ok : press the button to initialize the process.

Button Cancel : press the button to close the *dialog*.

Current key frame editing

In order to change the properties of the key frames, set the relevant number in the *field*  and press the *button* . The *Modify Key dialog* appears.



Field Frame : defines the number of the current key frame.

Fields Position : defines the current position of the camera's center of mass in the X, Y and Z axis.

Button Update right to the *fields Position* : press the button to change parameters of the camera position for the current values.

Fields Rotation : defines the camera lens position.

Button Update right to the *fields Rotation* : press the button to change parameters of the camera position for the current values.

Field Motion Blur : defines the value of the “Motion blur” effect for the current frame.

Button Ok : press the button to initialize the process.

Button Cancel : press the button to close the *dialog*.

Video Clip Creation

The flyby trajectory can be saved as a video clip. For this create a flyby trajectory, set the key frame to start recording with and select the *command Terrain→Capture Video* in the *Main menu*. The **Video Capture dialog** appears.



Group File : defines a name of the next video clip.

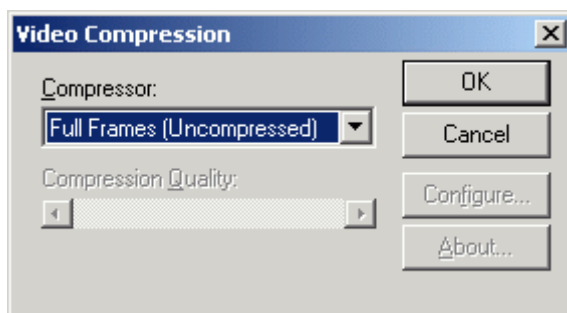
Group Port Size : defines the video clip size in pixels.

Field Rate, frames/sec : defines the number of frames per second.

Button Start : press the button to initialize the process.

Button Cancel : press the button to close the *dialog*.

Press the *button Start* in the **Video Capture dialog** and the **Video Compression dialog** appears. Select the video codec type as well as the compression and quality parameters.



For the video clip coding the embedded video codecs are used. In order to set the video codec parameters see the Technical manual.

Operations with the 3D Objects and Models

Usage of the 3D Models

You may add 3D models to the created 3D terrain. These 3D models are stored in the internal format supported by the software application. **3D Studio MAX** models can be imported.


In order to import a model start the **conv3ds.exe** utility in the command line. This utility is located in the subdirectory **Tools** of the root program directory (e.g., **C:\Program Files\RSD Center ScanEx\ScanEx Image Processor\Tools**). Use the following syntax:

conv3ds.exe /s<model's size in meters> <a file in the 3ds format>.

E.g., you would like to import the house.3ds file and to set the model size equal to 40 meters. The command should be as follows:

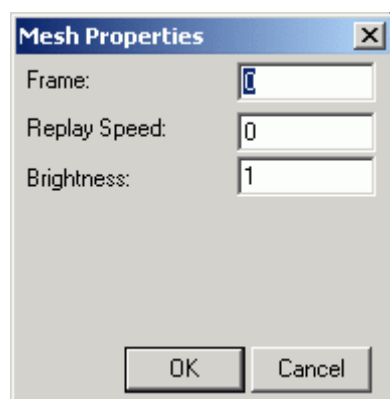
conv3ds.exe /s40 house.3ds

The file "house.mesh" will be created.

In order to add an imported model to the 3D terrain, press *a hot key* **Add Mesh**  in the *Toolbar* and indicate the point on the landscape to place the model on.

In order to remove a model press the *button* **Remove Mesh**  in the *Toolbar*.

In order to change the model illumination brightness and to activate the preset animation, select the required model type in the *list* **Meshes** of the *Toolbar* and use the *command* **Terrain→Objects→Properties**. The **Mesh Properties** *dialog* appears.



Field **Frame** : defines the first frame for the preset animation replay.

Field **Replay Speed** : defines the speed of the preset animation replay.

Field **Brightness** : defines the illumination brightness.

Button **Ok** : press the button to initialize the process.

Button **Cancel** : press the button to close the *dialog*.

In order to update the illumination brightness it is necessary to check off and then on the *flag Use Display Lists for Meshes* located in the *group Performance and Quality* of the *Preferences...dialog*.

Cloud and Fog Simulation

In order to create a cloud or a fog select the *command Terrain→Objects→Create Clouds* in the *Main menu*. The **Create Clouds / Volumetric Fog** *dialog* appears.

Clouds and Volumetric Fog

Name:

Grid Size

Length:
Width:
Height:

Animation

Enabled: ☐
Period, sec:
Random Seed:

Rendering Quality

Number of Billboards:

Shape

Smoothness:
Density:
Transparency:
Sharpness:

$$f(x) = 1 - \text{Smoothness}^{\text{Sharpness}(x - (1 - \text{Density}))}$$

Field Name : defines the object name.

Group Grid Size defines the size of the 3D object. An object's size is set as the degree of 2, e.g. the values **6*6*4** mean that the size of the 3D object will be $(2^6)*(2^6)*(2^4) = 64*64*16$ pixels.

Field Length : defines the 3D object's length. The range of values is from 4 to 8.

Field Width : defines the 3D object's width. The range of values is from 4 to 8.

Field Height : defines the 3D object's height. The range of values is from 4 to 8.

Group Animation defines cloud animation parameters.

Flag Enabled enables / disables animation.

Field Period, sec : defines a period of the complete animation cycle.

Field Random Speed : defines a random value for the animation start. By varying this parameter you can change the cloud internal structure.

Group Rendering Quality defines parameters of the cloud rendering quality.

Field Number of Billboards : defines the number of the 2D textures, which form the cloud. The more textures the higher the quality of the cloud rendering. The maximal number is 256.

Group Shape defines the shape and properties of the cloud.

Field Smoothness : defines smoothing inside a cloud. The range of values is from 0.1 to 1 (the less the number the less smoothing).

Field Density : defines the cloud density. The range of values is from 0.1 to 1 (the less the value the higher the degree of structure).

Field Transparency : defines the cloud transparency (the degree of cloud permeability for the solar light). The range of values is from 1 to 100.

Field Sharpness : defines transparency at the cloud's edge. The range of values is from 1 to 1024 (the higher the value the less the cloud edge transparency).

Button Load : press the button to load 3D object parameters from the file.

Button Save : press the button to save the set parameters to a file.

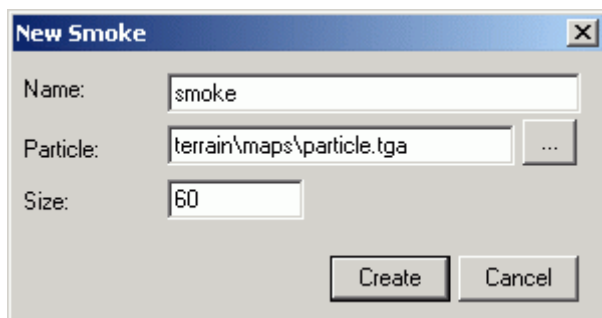
Button Create : press the button to initialize the process.

Button Cancel : press the button to close the *dialog*.

You may change the shape of the created cloud or fog. Select the required 3D object in the *list Meshes* in the *Toolbar* and use the *command Terrain→Objects→Properties*. The **Create Clouds / Volumetric Fog dialog** appears.

Creation of the 3D Object – “Smoke”

In order to create a 3D “smoke” object select the *command Terrain→Objects→Create Smoke*. The **New Smoke dialog** appears.



In the *field Name* specify the 3D object's name. This name will appear in the *list Meshes* in the *Toolbar*.

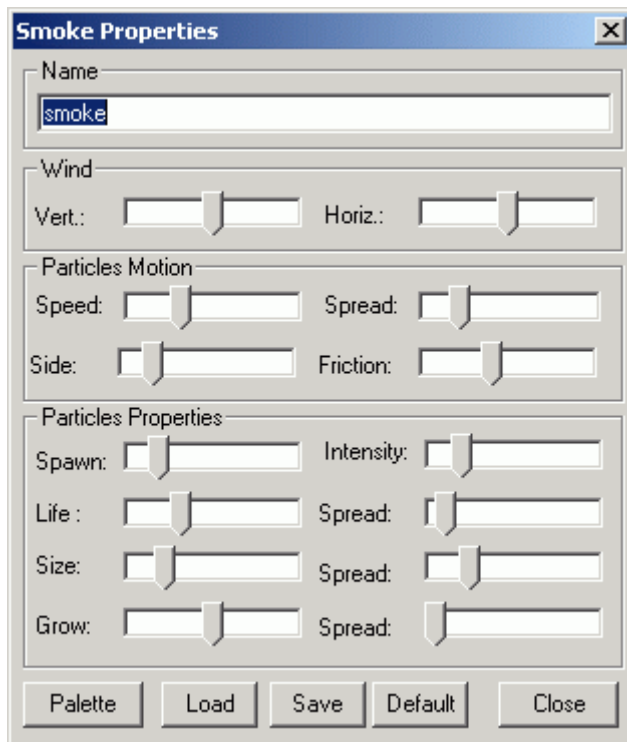
In the *field Particle* specify a texture to be used for the smoke simulation. The textures can be presented in one of the supported formats (**BMP, JPG, GIF, TGA**). The software module supports textures with the alpha channel.

In the *field Size* set the size of the 3D object in meters.

Button Create : press the button to initialize the process.

Button Cancel : press the button to close the *dialog*.

You may change the shape of the simulated smoke in an interactive mode. Select the required object in the *list Meshes* of the *Toolbar* and use the *command Terrain→Objects→Properties*. The **Smoke Properties** *dialog* appears.



In the *list Name* you may change the name of the object.

Group Wind defines the wind direction and strength.

Slider Vert : changes the wind strength in the vertical direction.

Slider Horiz : changes the wind strength in the horizontal direction.

Group Particle Motion : defines motion of the cloud of particles forming the smoke.

Slider Speed : changes the initial motion speed.

Slider Spread : changes the spread area depending on the initial speed (**Speed**).

Slider Side : changes the motion direction (particles' recession sideward).

Slider Friction : changes the particles' braking.

Group Particle Properties : defines the particles' properties.

Slider Spawn : changes the velocity of a new particle emission (the new particle birth rate).

Slider Life : changes the particles' lifetime.

Slider Spread : (right to **Life**) changes the area of the particle distribution for the parameter **Life**.

Slider Size : changes the particles' initial size.

Slider Spread : (right to **Size**) changes the particles' spread area for the parameter **Size**.

Slider Grow : changes the particles' growth rate.

Slider Spread : (right to **Grow**) changes the particles' spread area for the parameter **Grow**.

Slider Intensity : changes the transparency of the 2D texture.

Button Palette : press the button to load a color gradient palette, which can be used for coloring the “smoke” object.

Button Load : press the button to load 3D object parameters from the relevant file.

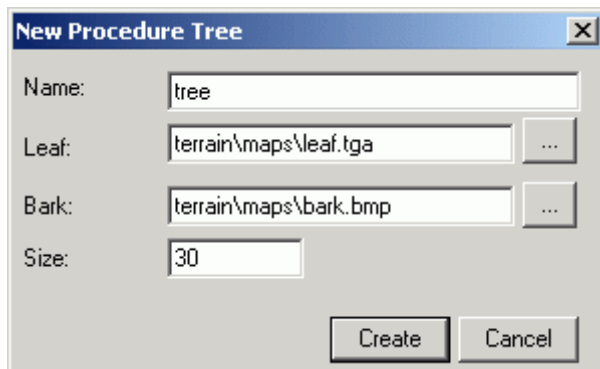
Button Save : press the button to save the set parameters to a file.

Button Default : press the button to set the default parameters.

Button Close : press the button to close the *dialog*.

Creation of Trees

In order to create a 3D object “tree” use the *command* **Terrain→Objects→Create Tree**. The **New Procedure Tree** *dialog* appears.



Field Name : defines a name for the 3D object; this name will be shown in the *list Meshes* in the *Toolbar*.

Field Leaf : defines the texture to be used as leaves. The textures can be presented in one of the supported formats (**BMP, JPG, GIF, TGA**). The software module supports textures with the alpha channel.

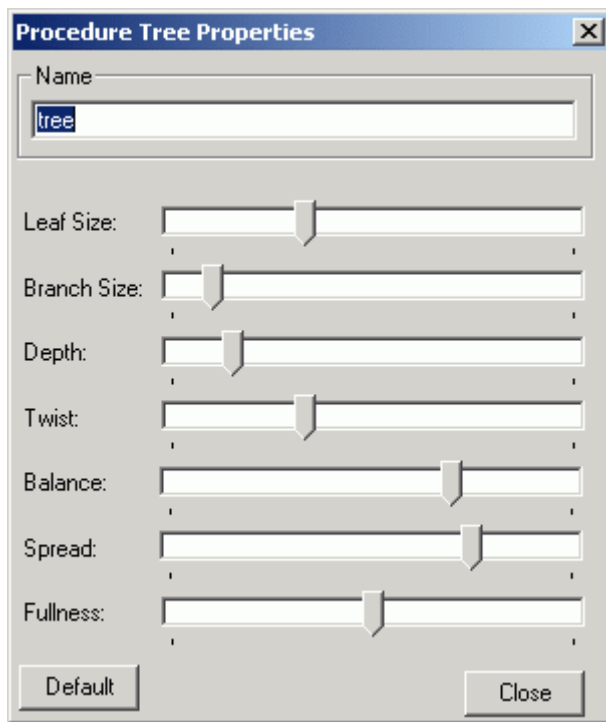
Field Bark : defines the texture to be used as trunks. The textures can be presented in one of the supported formats (**BMP, JPG, GIF, TGA**). The software module supports textures with the alpha channel.

Field Size : defines the size of the 3D object in meters.

Button Create : press the button to initialize the process.

Button Cancel : press the button to close the *dialog*.

You may change a shape of the created tree interactively. For this select the required 3D object in the *list Meshes* in the *Toolbar* and use the *command* **Terrain→Objects→Properties**. The **Procedure Tree Properties** *dialog* appears.



Field Name : allows changing the name of the 3D object.

Slider Leaf Size : changes the size of leaves.

Slider Branch Size : changes the size of the tree's trunk.

Slider Depth : changes the level of detail for a tree drawing.

Slider Twist : changes the tree's shape by twisting.

Slider Balance : changes the tree's symmetry.

Slider Spread : changes the shape of the tree's crown.

Slider Fullness : changes the number of leaves in the crown.

Button Load : press the button to load the 3D object parameters from the relevant file.

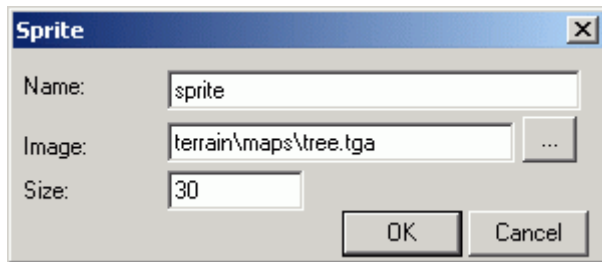
Button Save : press the button to save the set parameters to a file.

Button Default : press the button to set default parameters.

Button Close : press the button to close the *dialog*.

Creation of 2D Textures with the Vertical Disposition (Sprites).

2D textures can be used as pseudo 3D objects like trees, signs and others. In order to place a 2D texture select the *command* **Terrain→Objects→Create Sprite** in the *Main menu*. The **Sprite dialog** appears.



Field Name : defines the name of the object; this name is to be shown in the *list Meshes* in the *Toolbar*.

Field Image : specifies a path to the texture file. The textures can be presented in one of the supported formats (**BMP, JPG, GIF, TGA**). The software module supports textures with the alpha channel. The texture size is a degree of 2.

Field Size : defines the object's size in meters.

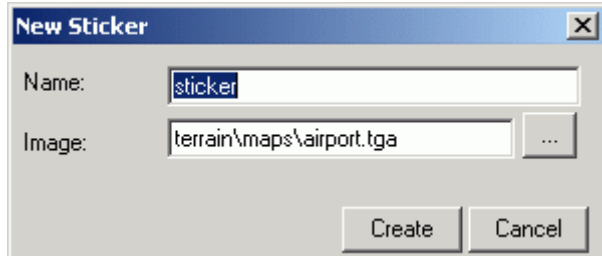
Button Create : press the button to initialize the process.

Button Cancel : press the button to close the *dialog*.

You may change the size and the texture used for the created object. For this select the relevant 3D object in the *list Meshes* in the *Toolbar* and use the *command* **Terrain→Objects→Properties**. The **Sprites dialog** appears. You may change the size value and select another file name for the texture in the corresponding fields of the dialog.

Creation of the 2D Textures with the Horizontal Disposition (Sticker).

You may use 2D textures to add inscriptions, photos and other information to the 3D terrain. In order to set the 2D texture, select the *command* **Terrain→Objects→Create Sticker** in the *Main menu*. The **New Sticker** *dialog* appears.



Field Name : defines the name of the object; this name is to be shown in the *list Meshes* in the *Toolbar*.

Field Image : specifies the path to the texture file. The textures can be presented in one of the supported formats (**BMP, JPG, GIF, TGA**). The software module supports textures with the alpha channel. The texture size is a degree of 2.

Button Create : press the button to initialize the process.

Button Cancel : press the button to close the *dialog*.

You may change the object size and location with the standard methods using relevant tools from the *Toolbar*.


Editing and Manipulating the 3D Objects and Models Placed

Adding a copy of a 3D object or model

There are two ways to add copies of objects and models:

- Manually
- Automatically within the vector contour.

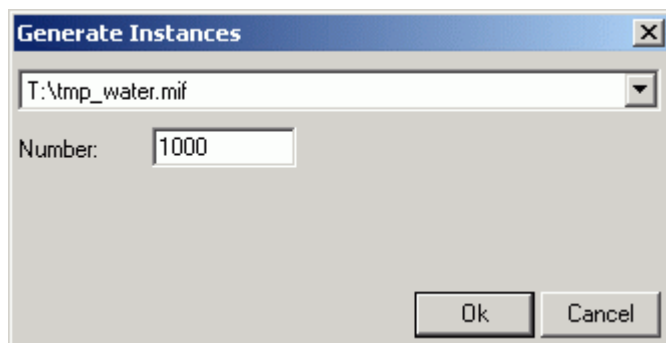
Adding a Copy Manually

For adding a copy of a 3D object or model manually select the required type of the object in the *list Meshes* of the *Toolbar* and press the *hot button Add Instance* . Press the left button of the mouse to place the model's copy on the landscape. Then press the **Esc** key on the keyboard.

Adding a Copy Automatically

Since an automated adding of the copies of 3D objects is based on vector contours, at first it is necessary to load a vector map with the contours presented as polygons.

In order to add copies of objects in the automated mode select the required type of the object in the *list Meshes* in the *Toolbar* and use the *command Terrain→Instances→Generate Instances* of the *Main menu*. The **Generate Instances** dialog appears.



Select the required vector layer in the above given *list*.

Field Number : defines the number of the object's copies.

Button Ok : press the button to initialize the process.


Button Cancel : press the button to close the dialog.

It is necessary to keep in mind that setting a large number of copies for the 3D objects can significantly reduce the total operating efficiency.

Selecting the 3D Objects

There are three ways to select 3D objects:

- Manually.
- To select all the copies of the objects of the chosen type.
- To select all objects.

To select objects manually use the **Select Instance**  *instrument* in the *Toolbar*, point the cursor to the required object and press the left button of the mouse. A cube with white sides surrounding objects indicates the selected object.

To select all the copies of the 3D object choose the required type in the *list Meshes* in the *Toolbar* and use the *command Terrain→Instances→Select Mesh* of the *Main menu*.



To select all the 3D objects placed, use the *command Terrain→Instances→Select All*.

Deletion of the 3D Objects Placed




To remove the 3D objects, select the required object and use the *command Terrain→Instances→Delete* of the *Main menu*.

Changing the Location of the 3D Objects

You may move objects in both the vertical and horizontal planes. In addition you may rotate an object in three planes.

In order to move an object in either vertical or horizontal plane select the required object, use the **Move Instance** *instrument* in the *Toolbar* and move to the required place. The **Move Instance**  *instrument* provides for moving in the horizontal plane and the  *instrument* – in the vertical plane. For shifting between the two instruments press the *hot button Move Instance* in the *Toolbar* again.

In addition you may force objects to be placed onto the 3D terrain's surface. For this select the required objects and use the *command Terrain→Instances→Land* of the *Main menu*.


You can rotate 3D objects using the **Rotate Instance** *instrument*. Select the required object, then choose one of the three planes and rotate the object using the relevant *instrument*. For rotation in the horizontal plane the *button* looks like ; for rotation in the vertical plane - ; for changing the roll - . Press the *button* to switch between the modes.

Changing the Size of 3D Objects

There are two ways to change the size of the 3D objects placed:

- Changing properties of all the copies of the 3D object of the selected type.
- Changing size for the selected 3D objects.

To change the size for all the copies of the 3D object select the required type in the *list Meshes* in the *Toolbar* and use the *command Terrain→Objects→Properties*. Depending on the object type a corresponding *dialog* appears where you may change its size. For more details see the corresponding chapter of this User's Manual.

To change the object's size select the 3D object, choose the **Scale Instance**  *instrument* in the *Toolbar*, place the cursor onto the selected object and keeping depressed the left button of the mouse change the object's size.

Disabling of the 3D Object Selection

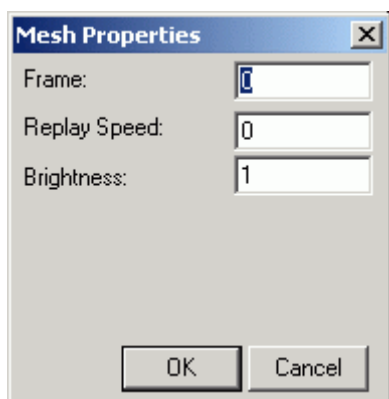
Selection disabling can be useful to freeze objects in the 3D terrain. For this select 3D objects and use the *command Terrain→Instances→Freeze* of the *Main menu*. To enable selection, use the *Terrain→Instances→Unfreeze* *command*.

Creation of the 3D Model Animation



You can use two types of animation:

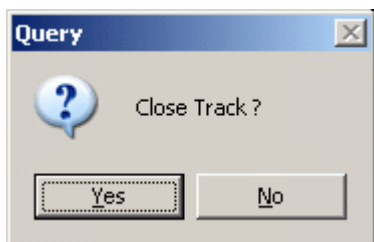
- Use of the preset animation saved in the **3D Studio MAX** file.
- Creation of the animation (setting object motion trajectories).

In order to switch on the preset animation it is necessary to select the 3D model with the preset animation and use the *command Terrain→Objects→Properties* of the *Main menu*. The **Mesh Properties** *dialog* appears.



In the *field Frame* set the frame to be the first one in the animation replay. It is necessary to set the replay speed in the *field Replay Speed*.

In order to create the 3D model motion trajectory, press the *hot button* **Attach Instance**  in the *Toolbar*, place the cursor onto the required model and press the left button of the mouse. Thus, the camera will be attached to the selected model. Then, following the standard procedure (see the corresponding chapter of the User's Manual) specify the motion trajectory. On completing the trajectory recording press the *hot button* **Detach Instance**  in the *Toolbar* to detach the camera. A message offering to close the trajectory appears.



If you press "Yes" the trajectory will be automatically closed between the first and last points. Otherwise it remains open.

To switch animation on, select the *command* **Terrain→Instances→Animate** in the *Main menu*.

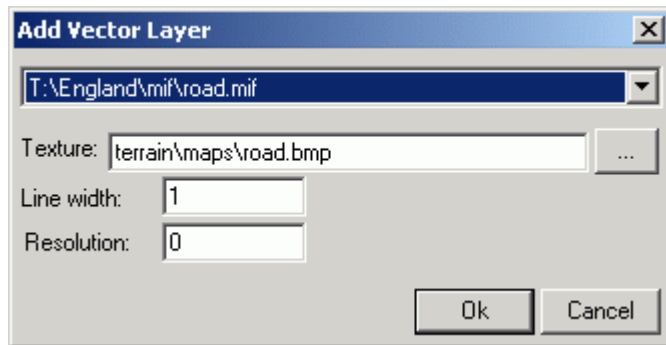
It is necessary to keep in mind that standard tools of the camera motion trajectory creation are used. Thus, you need to delete the previous trajectories.

Usage of the Vector and Raster Thematic Layers

Adding Vector Layers

Vector layers can be used to place roads, rivers and other objects. Polylines and polygons can be used to place objects on the 3D terrain.

To add vector layers, select the *command* **Terrain→Objects→Add Vector Layer** in the *Main menu*. The **Add Vector Layer** dialog appears.



The above given *list* specifies the required vector layer. Beforehand it is necessary to load this layer to the application (see the corresponding chapter of the User's Manual).

Field Texture : specifies the path to the texture file, which is to be used for the vector layer display. The textures can be presented in one of the supported formats (**BMP, JPG, GIF, TGA**). The software module supports textures with the alpha channel. The texture size is a degree of 2.

Field Line width : defines the width for polylines in millimeters.

Field Resolution : defines the value from 0 to 4; the value controls the degree of the relief modification under the vector layer. For the zero value the relief under the vector layer becomes simpler 32 times relative to the initial state; for the case of 1 – 16 times and for the case of 4 – two times respectively.

Button Ok : press the button to initialize the process.

Button Cancel : press the button to close the *dialog*.

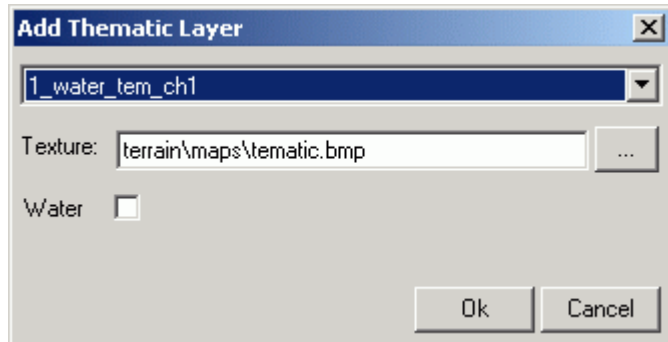
It is impossible to change the shape, the used texture and the size of the vector layer after its loading. In order to make any change it is necessary to delete the vector layer and then load it again with the modified properties.

Usage of the Raster Thematic Layers

It is possible to place additional raster thematic layers (water surfaces, roads, forests, etc.) onto the finished 3D landscape.

The raster thematic layer should have the same spatial resolution and the same cartographic projection as the basic layer. The raster thematic layer is to be presented as a bit mask.

In order to load the bitmap thematic layer use the **Terrain→Thematic Layers→Add Thematic Layer** *command* of the *Main menu*. The **Add Thematic Layer** *dialog* appears.



Select the layer to be loaded from the *list* given above.

Field Texture : defines the texture file. While creating the “water” layer it is not necessary to indicate the texture type as in this case the texture with reflection is created automatically.

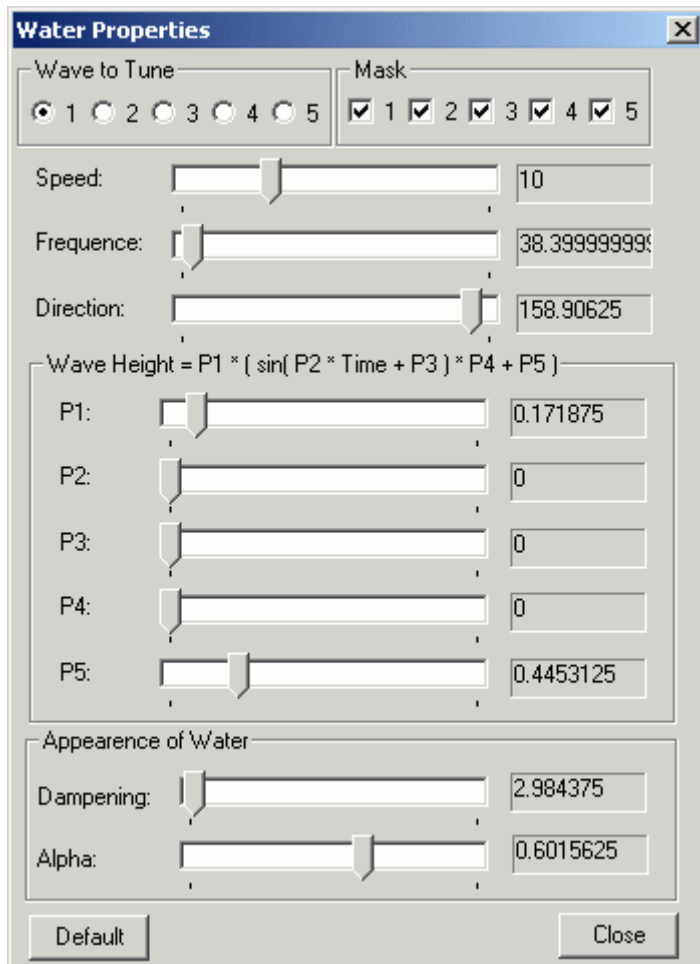
Flag Water indicates that a thematic layer “water” is to be created.

Only one thematic layer “water” can be used and it must be created the first if you create several thematic layers.

It is possible to delete the last of the thematic layers created. For this use the **Terrain→Thematic Layers→Delete Last Thematic Layer** *command*.

Setting the Thematic Layer “Water” Properties

The thematic layer “water” is specific and its display parameters can be changed. It is possible to simulate waves for the thematic layer “water”. To change the display parameters for the thematic layer “water” use the **Terrain→Thematic Layers→Tune Water** *command*. The **Water Properties** *dialog* appears.



Group Wave to Tune is used to set the wave properties. It is possible to set five levels of waves with different parameters. In order to change the parameters select one of the levels.

Group Mask enables / disables usage of the waves' levels.

Slider Speed : changes the wave speed.

Slider Frequency : changes the wave oscillation frequency.

Slider Direction : changes the wave direction.

Group Wave Height provides for setting the wave's height. The height is calculated by the following formula:

$$\text{Height} = P1 * (\sin(P2 * \text{Time} + P3) * P4 + P5)$$

The wave's height is defined by the **P1**, **P2**, **P3**, **P4**, **P5** coefficients which are set by moving sliders.

Group Appearance of Water provides for the parameters of a layer display.

Slider Dampening provides for setting the level of detail for wave display.

Slider Alpha provides for setting the level of the texture transparency.

Button Default : press the button to load the default settings.

Button Close : press the button to close the *dialog*.